February 2009
IYA Discovery Guide

This Month's Theme:

Our Solar System

Featured Activity:

Spotting Craters

Featured Observing Object:

Earth's Moon

The International Year of Astronomy is a global celebration of astronomy and its contributions to society and culture, highlighted by the 400th anniversary of the first use of an astronomical telescope by Galileo Galilei.
Join us as we look up! http://astronomy2009.us

The Astronomical Society of the Pacific increases the understanding and appreciation of astronomy by engaging scientists, educators, enthusiasts and the public to advance science and science literacy.
http://www.astrosociety.org

February's Topic:
Our Solar System

Our Solar System – the Sun and everything in orbit around it – is full of mystery and intrigue. Some planets spin backwards; Mars has polar ice caps that harbor water ice; and blazing volcanoes spew hot magma on Jupiter's moon Io. Thanks to innovative NASA space missions, scientists have been busy making discoveries and finding clues to understanding some of these mysteries.

Early observers and philosophers believed that the Sun and all the other celestial bodies revolved around Earth. Four hundred years ago this year, Galileo Galilei's discoveries using his new telescope supported the concept of a "solar system" in which all the planets, including Earth, revolve around the Sun. When Galileo pointed his telescope at Jupiter, he saw that Jupiter was not a star, but a sphere with orbiting satellites. In the centuries since his revolutionary discoveries, we have come a long way in our understanding of our Solar System.

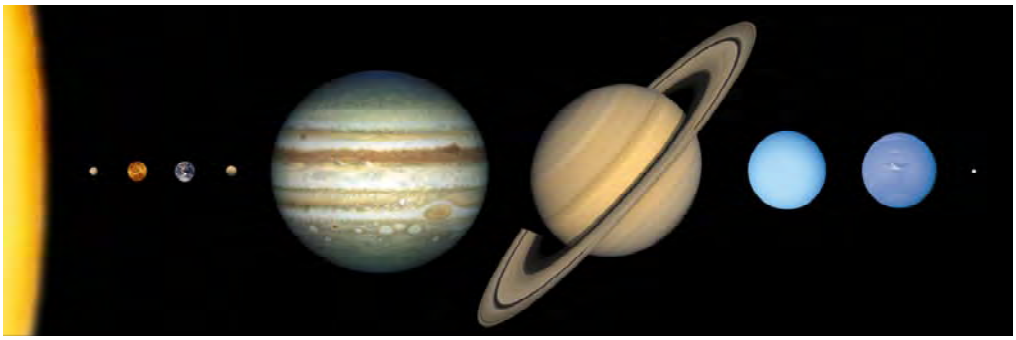

Image credit:
Lunar and Planetary Laboratory

NASA has sent space probes to explore the eight planets, as well as comets and asteroids. Recent Mars missions have been uncovering secrets of the Martian terrain and soil. The Cassini spacecraft has been sending back breathtaking images of Saturn and its moons. In the realm of icy bodies beyond Neptune and recently reclassified from planet to "dwarf planet/plutoid", Pluto will be visited by the New Horizons spacecraft in 2015.There are many future missions that promise to continually expand our knowledge.

Before humans travel to other planets, we will return to Earth's Moon to explore it anew. The Lunar Reconnaissance Orbiter (LRO) and Lunar CRater Observation and Sending Satellite (LCROSS) missions are scheduled to launch in 2009. LRO will spend a year orbiting and mapping the surface of the moon and characterizing landing sites. LCROSS may soon find out if there is water in the bottom of some lunar craters when it impacts the surface later in the year.

Using the activity found here, see how lunar craters are made and when is the best time to view the Moon.

Learn more about our Solar System from NASA.
Find more activities featured during IYA 2009.
See what else is planned for the International Year of Astronomy.

National Aeronautics and Space Administration
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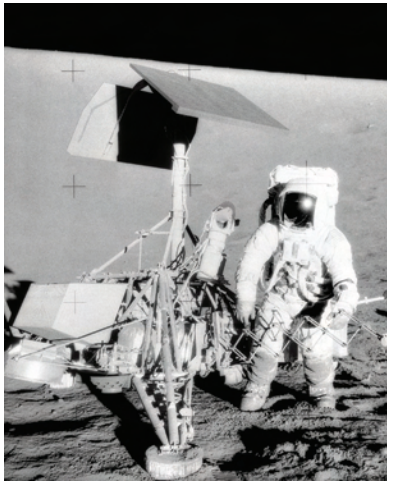
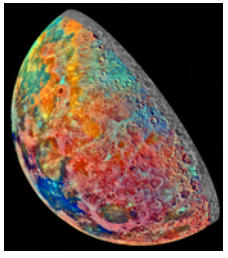
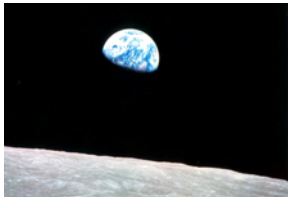
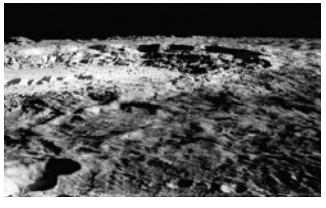
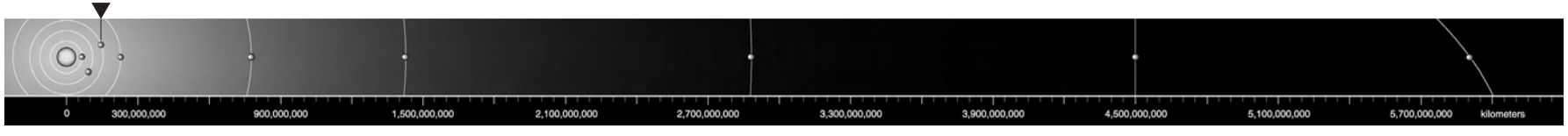
Earth's Moon











National Aeronautics and Space Administration
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Earth's Moon

The regular daily and monthly rhythms of Earth's only natural satellite, the Moon, have guided timekeepers for thousands of years. Its influence on Earth's cycles, notably tides, has also been charted by many cultures in many ages. The presence of the Moon stabilizes Earth's wobble on its axis, leading to a stable climate over billions of years, which may have affected the course of the development and growth of life on Earth. From Earth, we see the same face of the Moon all the time because the Moon rotates just once on its own axis in very nearly the same time that it travels once around Earth (called synchronous rotation). Patterns of dark and light features on the near side have given rise to the fanciful "Man in the Moon" description. The light areas are lunar highlands. The dark features, called maria (Latin for seas), are impact basins that were filled with dark lava between 4 and 2.5 billion years ago.

How did the Moon come to be? The leading theory, based on research, is that a Mars-sized body collided with Earth and the resulting debris from both Earth and the impactor accumulated to form our natural satellite approximately 4.5 billion years ago (the age of the oldest collected lunar rocks). When the Moon formed, its outer layers melted under very high temperatures, forming the lunar crust, probably from a global "magma ocean" — a sea of molten rock. The lunar highlands contain the remnants of rocks that floated to the surface of the magma ocean.

After the ancient time of volcanism, the Moon cooled and has since been nearly unchanged, except for a steady rain of "hits" by meteorites and comets. Impacts over billions of years have ground up surface areas into powder. Because the Moon has essentially no atmosphere, even the tiniest meteorites strike the surface. The Moon's surface is charcoal gray and sandy, with much fine soil. This powdery blanket of lunar soil is called the lunar regolith. The regolith is thin, ranging from about 2 meters (7 feet) on the youngest maria to perhaps 20 meters (70 feet) on the oldest surfaces in the highlands.

Four impact craters are used to date objects on the Moon: Nectaris, Imbrium, Eratosthenes, and Copernicus. Lunar history is carved up into time segments associated with the date of each crater. A Copernican feature, for example, is associated with a crater that is similar in age to the Copernicus impact crater, that is, 1 billion years old or less.

The Moon was first visited by the U.S.S.R. spacecraft Luna 2 in 1959, and a number of U.S. and U.S.S.R. robotic spacecraft followed. The U.S. first sent a series of Ranger spacecraft, designed to relay images and data and then crash-land onto the surface. This series was followed by the Surveyors, the first U.S. spacecraft to make lunar soft-landings. The first human landing on the Moon was on July 20, 1969. Twelve American astronauts walked upon its surface and brought back 382 kilograms (842 pounds) of lunar rock and soil to Earth during the Apollo lunar surface exploration missions of 1969 to 1972. The chief repository of the Apollo samples is NASA's Johnson Space Center in Houston.

Startling results from the Clementine and Lunar Prospector spacecraft indicate that there may be water ice on the Moon. Though a controlled crash of the Lunar Prospector in 1999 produced no observable signature of water, the issue of whether ancient cometary impacts delivered ice that is harbored in dark, cold areas of the Moon is still an open question.

In 2004, President George W. Bush announced a new Vision for Space Exploration that includes sustained robotic and human exploration of the solar system and beyond. It begins with robotic exploration of the Moon with an orbiter and then a lander, with a human return to the Moon by 2018. The Moon would be a testbed for technologies to support human exploration of the Moon, Mars, and beyond.

FAST FACTS

Mean Distance from Earth	384,400 km (238,855 mi)
Orbit Period	27.32 Earth days
Orbit Eccentricity (Circular Orbit = 0)	0.05490
Orbit Inclination to Ecliptic	5.145 deg
Inclination of Equator to Orbit	6.68 deg
Rotation Period	27.32 Earth days
Equatorial Radius	1,737.4 km (1,079.6 mi)
Mass	0.0123 of Earth's
Density	3.341 g/cm^3 (0.61 of Earth's)
Gravity	0.166 of Earth's
Temperature Range	–233 to 123 deg C (–387 to 253 deg F)

SIGNIFICANT DATES

1610 — Galileo Galilei is the first to use a telescope to make scientific observations of the Moon.
1959–1960 — Luna 1, 2, and 3 are the first to fly by, impact, and photograph the far side of the Moon.
1966 — Surveyor 1 makes the first soft landing on the Moon.
1969 — Astronaut Neil Armstrong is the first of 12 humans to walk on the lunar surface.
1996 — Clementine data indicate water ice at the south pole.
1998 — Lunar Prospector data indicate that ice exists at both lunar poles.

ABOUT THE IMAGES

1 The dark areas of this lunar image are lava-filled impact basins. The bright ray crater on the bottom is the Tycho impact basin.

2 Apollo 12 astronaut Charles Conrad visits Surveyor 3, a robotic spacecraft that landed on the Moon three years earlier.

3 This boot print marks one of the first steps human beings took on the Moon in July 1969.

4 False-color images help scientists identify different types of soil on the Moon's surface.

5 An illustration of future astronauts investigating a lava cave on the Moon.

6 The Apollo 8 crew took this picture of Earth rising over the surface of the Moon in 1968.

7 Copernicus Crater is part of the youngest assemblage of lunar rocks. The photo was taken by Lunar Orbiter 2 in 1966.

FOR MORE INFORMATION

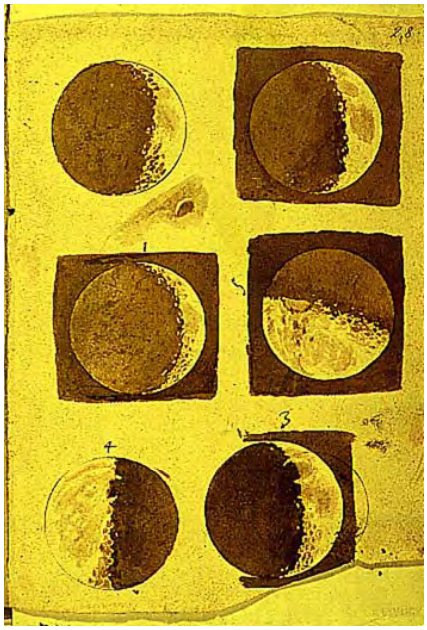
solarsystem.nasa.gov/planets/profile.cfm?Object=Moon

LG-2005-12-568-HQ — JPL 400-1253G 12/05

February 2009 Featured Observing Object:

Moon

Finder Chart



For information about Earth's Moon:
http://solarsystem.nasa.gov/planets/profile.cfm?Object=Moon

To view: unaided eyes, binoculars, or telescope

The Moon orbits the Earth once every month, so it will appear in a different place in the sky each night. At the beginning of February 2009, the Moon is found high above the southern horizon after sunset. On the 8 February, look toward the east just after sunset to see the full Moon rising. For several days after that, you'll have to wait until well after sunset to see the Moon or else look for it in the daytime sky. At the end of February, the Moon is once again visible just after sunset in the west as a thin crescent near bright Venus (see image below).

Look at the Moon through the telescope and see what Galileo saw 400 years ago (image above). The Moon has mountains, valleys, and craters. But does it have water?

Spotting Craters

Why is the Full Moon a Poor Time to Observe the Moon?

About the Activity

Use a model of the surface of the Moon to show how shadows show more details than direct light. Participants see the difference between a full Moon and a partially dark Moon.

Materials Needed

- Packet of powdered hot cocoa mix
- Aluminum pan
- 5 pounds of flour
- Several small rocks
- Flashlight covered with a paper towel to diffuse the light
- Newspaper, if doing activity inside
- Plastic "moon" ball on a toothpick or skewer stick

Topics Covered

- Why shadows make viewing the Moon more spectacular.
- What do we see when looking at the Moon?

Participants

Use this activity with families, the general public, and school or youth groups ages 7 and up.

Location and Timing

This activity takes about 10-15 minutes and can be used at night or in a classroom that can be darkened. Not recommended for a windy night.

Included in This Activity

Preparation Instructions
Detailed Activity Description
Background Information
Helpful Hints

Preparation Instructions

- Fill aluminum pan almost to the rim with flour. Sprinkle with hot cocoa mix.
- Place the ball representing the Moon on a skewer stick and place it next to or in the pan of flour.
- Make a moonscape by using your hand to make a mountain range on one side of the pan.

Either poke holes in it with your fingers, or for more fun (and more mess!), have participants drop small rocks ("meteoroids") into the flour, simulating the early bombardment of the Moon by meteoroids.

*For an alternative and more permanent model, see **Helpful Hints**

Detailed Activity Description

Spotting Craters: Why is full Moon a poor time to observe the Moon?

Leader's Role	Participants' Role (Anticipated)
Presentation Tips: Many people think the full Moon is the best time to see a lot of detail on the Moon. This presentation addresses that idea.	
To Say: Shadows allow us to see features on the Moon! When you look at the full Moon through the telescope, it is difficult to clearly see the mountains and the craters. From a crescent phase to a few days on either side of full and there is a part of the Moon where craters and mountains can be clearly seen in strong relief. This activity illustrates why. The Moon's surface has mountains and a lot of what?	Craters
To Do: Point to the pan full of flour (or the play dough Moonscape). *To Say:* This represents a small area of the surface of the Moon. (Pointing to ball) Here's the whole Moon and this pan represents the middle area right here magnified (pointing to middle of ball where the small square is).	

Leader's Role	Participants' Role (Anticipated)
(If using the "Pan with Flour") To Say: We have some mountains here, but what's missing from our Moonscape? Right – let's make some! *To Do:* Show rocks (or wrapped bite-size candies). *To Say:* We'll take these rocks, representing meteoroids that bombarded the Moon early on, and drop them to create craters, like this. *To Do:* Hold hand up high above the pan and drop one rock. Pass out rocks to participants. *To Say:* Don't throw them. Just drop them. 	Craters! Drop rocks into flour.

Leader's Role	Participants' Role (Anticipated)
Presentation Tip: Encourage people to just drop their object into the flour. Your participants may want to THROW their objects into the flour. Discourage this. If they miss the pan, they might hit and hurt someone. To reduce the likelihood of injury have all the participants group themselves on one side of the pan. That way, if someone does throw their object at the pan, it will not hit anyone.	
(If using the "Play Dough Moonscape") ***To Say:*** We have a Moonscape here. What do you see? 	Mountains. Craters
 *To Do:* Using a flashlight covered with a paper towel to represent the Sun, have visitors move the Sun over the Moonscape, starting with the Sun high above the Moonscape (as in photo at left). *To Say:* How much of the Moon ball is lit up? Right now, we have a full Moon.	This whole side.

Leader's Role	**Participants' Role (Anticipated)**
To Say: Now move the Sun down toward the edge of the pan (as in photo below). How much of the Moon-ball is lit up? This is called a quarter Moon. How much more detail can we see? 	 Just half of it. A lot!
To say: Where must the Sun be for you see the craters and mountains best? When we look at a full Moon, the Sun is shining overhead from the viewpoint of someone standing in the middle of the Moon. *(Optional: you can stick a toothpick into the ball or into the Moonscape to represent a person)* Would that person have much of a shadow? When we look at a quarter Moon, now does the person have a shadow? So shadows bring out detail on the Moon. Ready to go look at the Moon through the telescopes?	 Near the edge. No. Yes, a long one. Yeah!

Leader's Role	Participants' Role (Anticipated)
Presentation Tip: At the end of the presentation, if you used the Pan with Flour and used wrapped candies instead of rocks, you can either: • (least messy option) pass out a candy from the original bag to each participant or • retrieve the candy from the flour using a potato masher or slotted spoon, Allowing participants to reach into the flour to retrieve their candy will result in flour-covered hands – not a good combination with telescope viewing.	
Optional Quote: "Mountain walls that tower tonight may appear insignificant tomorrow. Small craters that dot floors of larger rings under one illumination may be absent under others. Long clefts, clearly marked at times, vanish with the shifting of light and shadow." Leland S. Copeland in the April 1956 issue of Sky & Telescope.	

Background Information

Moon Phases

For a photo mosaic of the phases of the Moon:
http://www.astro.virginia.edu/class/oconnell/astr130/im/moon-phases-lrg-cidadao-sm.jpg

Moon's Rotation

Does the Moon rotate? Why does the Moon always keep the same face to Earth? What does the other side of the Moon look like?
A discussion of these topics can be found here:
http://www-spof.gsfc.nasa.gov/stargaze/SMoon.htm

Helpful Hints

Alternate method – To make a pre-made moonscape:

1. Use the recipe below to make your own dough (you will need to double or triple the batch).
2. Create a moonscape with the dough in plastic pan or tray (do not use an aluminum pan – the dough can corrode the pan over time). The type of foam tray used in grocery stores to package meat also works well. Wash the tray thoroughly before using.
3. Cover to store.

Make your own Play-Doh-like clay:
http://www.cooks.com/rec/doc/0,1611,147171-236192,00.html:

1 c. flour
1 c. boiling water
2 tbsp. cream of tartar
1/2 c. salt
1 tbsp. oil
Food coloring

Mix and knead together. This dough is not sticky and does not dry out unless left open to the air for several days. Store in a sealed container (plastic tubs are good).

THE UNIVERSE YOURS TO DISCOVER
INTERNATIONAL YEAR OF ASTRONOMY 2009

The Night Sky Network's International Year of Astronomy (IYA) Discovery Guides are supported and sponsored by these NASA Forums and missions:

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NASA Lunar CRater Observation and Sensing Satellite (LCROSS)
NASA Education Forum on the Structure and Evolution of the Universe
NASA Education Forum on Solar System Exploration
NASA Education and Public Outreach at Sonoma State University
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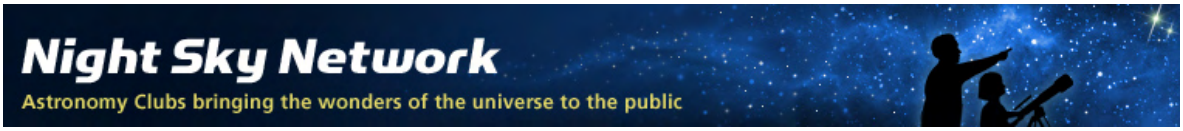
NASA's Kepler Discovery Mission



The Night Sky Network is a nationwide coalition of amateur astronomy clubs bringing the science, technology, and inspiration of NASA's missions to the general public.

We share our time and telescopes to provide you with unique astronomy experiences at science museums, observatories, classrooms, and under the real night sky.
http://nightsky.jpl.nasa.gov

The International Year of Astronomy (http://astronomy2009.us) aims to help citizens of the world rediscover their place in the Universe through the daytime and nighttime sky. Learn more about NASA's contributions to the International Year of Astronomy at http://astronomy2009.nasa.gov